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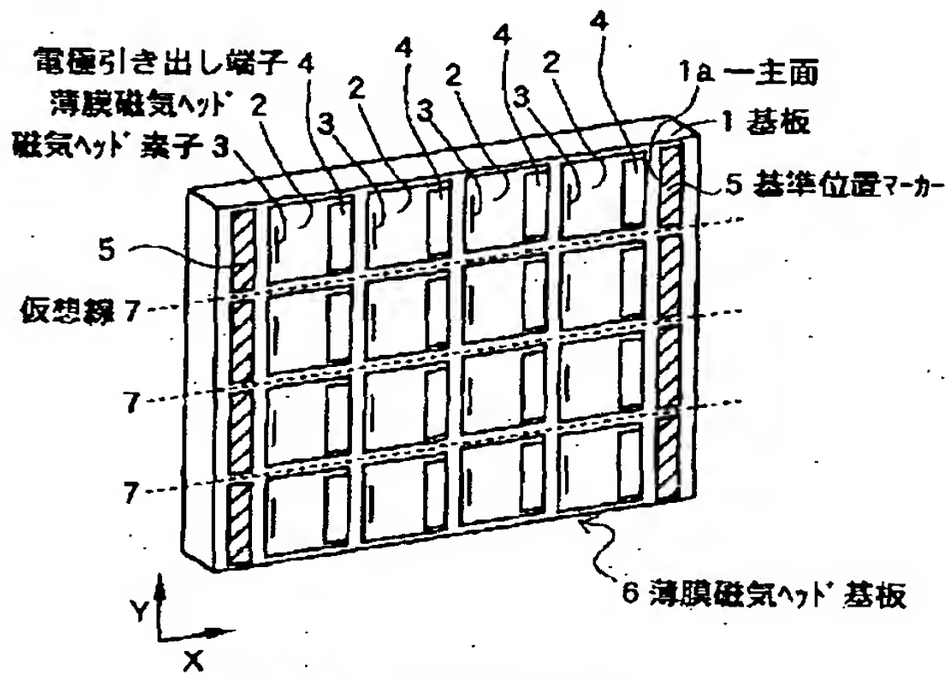
(71)出願人　000002185
ソニー株式会社
東京都品川区北品川６丁目７番35号
(72)発明者　山崎　昌彦
東京都品川区北品川６丁目７番35号　ソニー株式会社内
(74)代理人　弁理士　小池　晃　（外２名）

(54)【発明の名称】　複合型磁気ヘッドの製造方法

(57)【要約】
【課題】　組み立て時の組立精度と強度の向上を図ることができる複合型磁気ヘッドの製造方法を提供する。
【解決手段】　対向保護板１１を一方側面側１１ａを残して他方側面側１１ｂが断面略々凹状となる電極引き出し端子の露出溝１３を連続して形成し、接着ブロック１０を各チップに切断するに際して、各凹状の露出溝１３の後方の開口垂線側から切断する。



薄膜素子基板形成工程の斜視図

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【特許請求の範囲】
【請求項１】　電極引き出し端子を有する薄膜ヘッド素子が磁気記録媒体摺動面と直交する方向に複数配列形成されてなる薄膜磁気ヘッド基板を形成する工程と、
上記薄膜磁気ヘッド基板に対向して配される対向保護基板をその一方側面側を残して他方側面側が凹状の開口とされる櫛歯状に形成する工程と、
上記薄膜磁気ヘッド基板に上記対向保護基板を接合する工程と、
上記対向保護基板が接合された薄膜磁気ヘッド基板を切断して、各磁気ヘッド部に分離する工程と、
複数の磁気ヘッド部を磁気記録媒体走行方向に配列し、接合一体化する工程と、　を有することを特徴とする複合型磁気ヘッドの製造方法。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、例えばコンピュータ用データカートリッジ等の高密度記録可能な磁気記録再生装置に搭載して好適な複合型磁気ヘッドの製造方法に関する。
【０００２】
【従来の技術】高密度磁気記録に適した薄膜磁気ヘッドは、より高容量化へと移行しつつあるコンピュータ用のテープストリーマーなどの分野において、バルクタイプの磁気ヘッドに代わり採用化が進められている。
【０００３】特に近年は、より高密度化への対応により、記録用ヘッドとしてインダクティブヘッドを使用し、再生用ヘッドとして磁気記録媒体からの信号磁界を電気抵抗変化に変換し検出する磁気抵抗効果型磁気ヘッド（以下、ＭＲヘッドと称する。）が用いられている。
【０００４】この薄膜磁気ヘッドは、一般に、電極引き出し端子を有する薄膜ヘッド素子が複数形成された素子基板と、この素子基板に対向して配される対向保護板と、上記素子基板の磁気記録媒体との摺動部を補う並列保護板を備えた構成となされている。
【０００５】上記素子基板及び対向保護板は、薄膜ヘッド素子よりも該薄膜ヘッド素子のトラック幅方向において幅広となされ、磁気記録媒体との当たり特性を確保している。また、対向保護板は、薄膜ヘッド素子を保護するものであり、電極引き出し端子の位置に対応する位置にワイヤボンディング又は半田接続等のための露出溝が一側面に広く形成されている。
【０００６】このような薄膜磁気ヘッドは、その必要に応じて、インダクティブヘッドを有する薄膜磁気ヘッドとＭＲヘッドを有する薄膜磁気ヘッド等といった組み合わせで複数の薄膜磁気ヘッドが接着され複合型磁気ヘッドとされて使用に供される。
【０００７】ところで、このような複合型磁気ヘッドを構成する薄膜磁気ヘッド（ＭＲヘッドを含む）を製造するに際しては、半導体集積回路と同様に、磁気回路部を

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構成する磁気薄膜や導体コイル等が蒸着、スパッタリング等の真空薄膜形成技術や写真製版、エッチング等の手法を用いて作成されるため、一般的には３～５インチ程度の基板サイズで作成されることが多い。
【０００８】ここで、半導体集積回路の場合と同様に、薄膜形成過程における１ヘッド当たりに要する工程数を減らし、且つ１ヘッド当たりの歩留まりを稼ぎコストダウンを図る目的で、できるだけ基板サイズを大きくする一方、個々の薄膜ヘッド素子の形成に要する基板上の占有面積を必要最小限に小さくし、同一面積の素子基板１枚当たりから取れるヘッドの数ができるだけ多くなるようにする必要がある。
【０００９】ところが、薄膜ヘッド素子よりも幅の広い磁気記録媒体との摺動部を必要とする薄膜磁気ヘッド、例えばコンピュータ用テープストリーマーに用いられる薄膜磁気ヘッド等においては、薄膜ヘッド素子のない余白部分の占める面積が多くなるため、一枚の素子基板内に入れられるヘッドの数を多くすることができなくなってしまう。このような薄膜磁気ヘッドでは、薄膜形成工程が数十工程以上と全体の工程数中での占める割合が非常に多いことから、特に歩留まりの観点から結果的にはコストアップを招くことが多い。
【００１０】従来、かかる薄膜磁気ヘッドにおいては、上述の問題を回避するために、１ヘッド分の幅寸法を薄膜ヘッド素子の形成された素子基板のトラック幅方向の両端面に必要とする磁気記録媒体との摺動幅を補う並列保護板と上記薄膜ヘッド素子を保護する対向保護板とを後の工程で接着する方法を採っている。
【００１１】即ち、上記薄膜磁気ヘッドは、以下のような製造方法により製造されている。
【００１２】先ず、例えば図１０に示すように、先ず蒸着、スパッタリング、或いはエッチング等の薄膜形成技術を用いて薄膜磁気ヘッド３１を基板３０の表面にマトリクス状に形成し、薄膜磁気ヘッド基板３４を作製する。この薄膜磁気ヘッド３１には、薄膜ヘッド素子３２と、該薄膜ヘッド素子３２からの電極引き出し端子３３とが形成されている。
【００１３】次に、上記薄膜磁気ヘッド基板３４を図１０中点線で示す仮想線３５に沿って切断し、図１１に示すような切断ブロック３６を作製する。
【００１４】次いで、図１２に示すように、切断ブロック３６を対向保護板３７及び並列保護板３８と組み合わせ、樹脂或いはガラス等で接着する。これにより、図１３に示すような接着ブロック３９が作製される。
【００１５】ここで、対向保護基板３７は、薄膜磁気ヘッド３１の薄膜ヘッド素子３２を保護するもので、図１２に示すように、切断ブロック３６との接着側に断面略々コ字状の露出溝３７ａが一定間隔をおいて複数形成されている。この露出溝３７ａは、薄膜磁気ヘッド基板３４の電極引き出し端子３３の位置に対応した位置に対向

保護基板３７の両側面を貫通する溝として形成される。

【００１６】次に、図１３に示すように、仮想線４２と仮想線４３に沿って切断する。すなわち、先ず、砥石４０で仮想線４２に沿って切断して１チップに切り出し、次に、電極引き出し端子３３を露出させるために、砥石４１で仮想線４３に沿って切断する。

【００１７】このように切断すると、図１４に示すように、電極引き出し端子３３を露出させる露出溝３７ａが大きく形成された切断チップ４４が作製される。

【００１８】その後は、磁気記録媒体摺動面Ｓを、薄膜磁気ヘッド基板３４内に設けられたギャップ深さ研磨量を寸法で読みとるマーカー（以下、デプスマーカーと称する。）や電気抵抗の変化で検出する研磨モニター（以下、デプスモニターと称する。）等を用いて、予め定められたギャップ深さ寸法になるように制御して研磨し、図１５に示すような研削チップ４５を作製する。

【００１９】次いで、図１６に示すように、研削チップ４５の電極引き出し端子３３より印刷配線基板４６へワイヤーボンディング又は半田接続などを用いて電極配線を取り出し、ヘッドチップ４７が作製される。

【００２０】次に、図１７に示すように、上述のように形成されるヘッドチップ４７のうち、記録用磁気ヘッド素子が形成された記録用磁気ヘッドチップ４８と、再生用磁気ヘッド素子が形成された一対の再生用磁気ヘッドチップ４９と、消去用磁気ヘッド素子が形成された消去用磁気ヘッドチップ５０と、テープガイド５１とを組み合わせて、パーマロイなどから成るシールド枠５２内に位置決めし、樹脂などで固定する。これにより、複合型磁気ヘッド５３が作製される。

【００２１】

【発明が解決しようとする課題】ところで、記録用磁気ヘッドチップ４８と、一対の再生用磁気ヘッドチップ４９とは、接合一体化された複合型磁気ヘッド５３として使用に供されるが、上記従来の複合型磁気ヘッド５３では、以下に示すような不都合が生じる。

【００２２】すなわち、図１７に示す複合型磁気ヘッド５３を作製する場合、ヘッドチップ同士を組み合わせて各種位置調整を行う。その中で図１８に示すチルト調整を行う際には、通常は、各ヘッドチップ４８，４９の切断チップ、対向保護板３７及び並列保護板３８の厚み精度が得られているので、各ヘッドチップ４８，４９同士を側面基準板５７に当接し加圧することで調整する。しかしながら、このとき、各ヘッドチップ４８，４９の対向保護板の高さ寸法Ｈ２が切断チップ及び並列保護板の高さ寸法Ｈ１に比べ、薄膜ヘッド素子の電極引き出し端子３３を露出させる寸法分だけ短いため、当接し加圧する時、扇状に開き易く調整する上での安定性に問題があった。

【００２３】また、各ヘッドチップ４８，４９は、対向保護基板３７の後端側がすべて除去され、薄膜磁気ヘッド基板３４と対向保護基板３７とは、露出溝３７ａの上方側でのみ接着されている。したがって、対向保護基板３７は、従来の製造方法により接合一体化しても、隣接する薄膜磁気ヘッドとの接着側３７ｂの面積が小さいために、ヘッドチップ同士の接着面にズレが生じやすかった。このようなズレが生じると、各ヘッドチップ間での垂直度が正確に保たれず、磁気記録媒体との当たりにばらつきを生じさせる原因となる。

【００２４】さらに、従来の製造方法では、図１３に示すように、接着ブロック３９を砥石４０で仮想線４２に沿って切断する場合、あらかじめ薄膜磁気ヘッドに形成された切断基準位置マーカーが対向保護板３７に隠れているため、切断基準位置マーカー確認用溝入れをして接着ブロック３９をアライメントしなおさなければならない。さらには、砥石４１で仮想線４３に沿って電極引き出し端子３３を露出させるための切断も行わなければならないため、加工工程が多くなり、加工効率が悪くなっている。

【００２５】そこで、本発明は、かかる従来の技術的な課題に鑑みて提案されたものであって、組み立て時の組立精度と強度の向上が図られる複合型磁気ヘッドを加工工程数を最小限度に抑えて効率良く製造することができる複合型磁気ヘッドの製造方法を提供することを課題とする。

【００２６】

【課題を解決するための手段】本発明の複合型磁気ヘッドは、上記の課題を解決するために、電極引き出し端子を有する薄膜ヘッド素子が磁気記録媒体摺動面と直交する方向に複数配列形成されてなる薄膜磁気ヘッド基板を形成する工程と、上記薄膜磁気ヘッド基板に対向して配される対向保護基板をその一方側面側を残して他方側面側が凹状の開口とされる櫛歯状に形成する工程と、上記薄膜磁気ヘッド基板に上記対向保護基板を接合する工程と、上記対向保護基板が接合された薄膜磁気ヘッド基板を切断して、各磁気ヘッド部に分離する工程と、複数の磁気ヘッド部を磁気記録媒体走行方向に配列し、接合一体化する工程とを有することを特徴とする。

【００２７】本発明によれば、対向保護板をその一方側面側を残して他方側面側が凹状の開口とされる櫛歯状に形成するために、従来のように１チップに切り出した後に、更に、電極引き出し端子を露出させるための切断が不要となる。

【００２８】そして、対向保護基板が接合された薄膜磁気ヘッド基板を切断すると、電極引き出し端子上が解放されるとともに、各切断チップは対向保護板の一方側面部を残して切断される。したがって、このように製造された薄膜磁気ヘッドを有する複合型薄膜磁気ヘッドを組み合わせて作製する場合、対向保護板の一方側面部が残されているために、隣接する磁気ヘッド部側の面積が大きくなり、組立状態が安定化する。

【００２９】

【発明の実施の形態】以下、本発明を適用した具体的な実施の形態について図面を参照しながら詳細に説明する。

【００３０】本実施の形態は、記録用ヘッドを有する薄膜磁気ヘッドと、再生用ヘッドを有する薄膜磁気ヘッドと、消去用ヘッドを有する薄膜磁気ヘッドを接着した複合型の薄膜磁気ヘッドの製造方法に、本発明を適用した例について述べる。

【００３１】本実施の形態の複合型磁気ヘッドの製造方法においては、先ず図１に示すように、基板１の一主面１ａに蒸着、スパッタリング或いはエッチング等の薄膜形成技術を用いて薄膜磁気ヘッド２を、図中矢印Ｘで示す磁気記録媒体摺動面と直交する方向と図中矢印Ｙで示す上記薄膜磁気ヘッド２のトラック幅方向にマトリクス状に形成する。

【００３２】ここで、上記薄膜磁気ヘッド２には、磁気ヘッド素子３と該磁気ヘッド素子３からの電極引き出し端子４が形成されている。

【００３３】また同時に、上記基板１のＸ方向の両端であって上記薄膜磁気ヘッド２の形成されていない部分に、該薄膜磁気ヘッド２の形成位置に合わせて図中斜線部で示す複数の基準位置マーカー５を形成して薄膜磁気ヘッド基板６を作製する。

【００３４】そして、上記薄膜磁気ヘッド基板６を、最終的に磁気記録媒体（磁気テープ等）と接する摺動面となる面方向（Ｙ方向）に対して垂直の方向（Ｘ方向）をなす図中点線で示す仮想線７に沿って切断する。

【００３５】これにより、上記薄膜磁気ヘッド基板６が、図２に示すように、Ｘ方向、即ち上記磁気記録媒体摺動面に直交する方向に複数（ここでは４つ）の薄膜磁気ヘッド２が配列形成され、そのＸ方向の両端に基準位置マーカー５が形成されている切断ブロック８に分断される。

【００３６】次いで、図３に示すように、切断ブロック８と並列保護板９及び櫛歯状に形成された対向保護板１１を組み合わせ、樹脂或いはガラス等で接着する。これにより、図４に示すような接着ブロック１０が作製される。すなわち、磁気記録媒体との摺動部として機能する並列保護板９及び対向保護板１１との接着により、接着ブロック１０は、薄膜磁気ヘッド２のトラック幅方向の幅が該薄膜磁気ヘッド２よりも幅広の媒体摺動部を有する構成となる。

【００３７】ここで、上記対向保護板１１は、その全体形状が櫛歯状を呈してなる。すなわち、この対向保護板１１は、その一方側面側１１ａを残して、他方側面側１１ｂに電極引き出し端子４を解放する凹状の開口１３が形成されている。したがって、切断ブロック８と対向保護板１１との接着後も切断位置マーカー５と電極引き出し端子４が、凹状の開口１３から露出することになるため、ワークアライメントをすぐに行うことができる。

【００３８】次に、砥石１４で図４中仮想線Ａ－Ａに沿って切断して１チップに切り出すことで、図５に示すような切断チップ１５が作製される。この切断の際、前述した基準位置マーカー５を用いて切断する。

【００３９】ここで、上記対向保護板１１は、一方側面部１１ａを残して形成されているために、並列保護板９の片側に磁気記録媒体摺動面側からバック面側まで同じ厚みの箇所が形成される。

【００４０】この点、従来の製造方法では、電極引き出し端子上の対向保護基板を除去するために、薄膜形成基板の電極引き出し端子側から１チップ毎に先ず切断するとともに、その後更に、対向保護基板の後端側すべて除去という工程を要していた（図１３参照）。しかし、このような切断工程では、切断工数が多くかかる。このことは、薄膜磁気ヘッド基板２に連続して配される薄膜ヘッド素子３の数が増えれば増えるほど顕著になる。

【００４１】これに対して、本実施の形態の製造方法は、上記接着ブロック１０を各切断チップ１５に切断するに際して、上記凹状の開口１３の後方の開口垂線側から切断すれば足り（図４中、Ａ－Ａ線）、従来のように１チップに切り出した後に、更に、電極引き出し端子４を露出させるための切断が不要となる。しかも、対向保護板１１の一方側面部１１ｂが残されているために、隣接する磁気ヘッド側の面積が大きくなり、組立状態を安定化させることができる。

【００４２】その後は、この切断チップ１５における磁気記録媒体摺動面Ｓを、従来より使用されているデプスマーカーやデプスモニター等を用いて、予め定められたギャップ深さ寸法になるように制御し複数個の切断チップ１５を同時に研削ラッピングして、図６に示すような研削チップ１６を作製する。

【００４３】この時、上記薄膜磁気ヘッド２のデプスは、数μｍの精度で制御する必要がある。そこで、上述のように基板１上に薄膜磁気ヘッド２を形成すると同時に上述のデプスマーカーやデプスモニターを形成しておき、これによりデプス方向の研削量を確認しながら切断チップ１５のデプスのバラツキを抑え、且つ全体の加工工数を抑える。

【００４４】次いで、この研削チップ１６から薄膜ヘッド素子３の電極引き出し端子４より印刷配線基板１９へワイヤーボンディング又は半田接続などを用いて電極配線を取り出し、図７に示すようなヘッドチップ１が作製される。

【００４５】次に、図８に示すように、上記ヘッドチップ１のうち記録用磁気ヘッド素子が形成された薄膜磁気ヘッドチップ１Ａと、再生用磁気ヘッド素子が形成された一対の薄膜再生ヘッドチップ１Ｂと、消去磁気ヘッドチップ１Ｃと、テープガイド１７などを組み合わせてパーマロイなどから成るシールド枠１８に位置決めし、樹

脂などで固定する。これにより、複合型磁気ヘッド２１が作製される。

【００４６】このようして組み立てられた複合型磁気ヘッド２１は、図９に示すように、対向保護板１１の一方側面部１１ａが残されているために、各ヘッドチップ１Ａ，１Ｂは、並列保護板９と対向保護板１１の高さが同じ箇所が設けられる。したがって、側面基準板２０に当接し加圧しても、従来のように扇形に開くことはない。また、対向保護板１１が櫛歯状に形成されているために、ワイヤーボンディング等の接続作業が改善されると同時に歩留まりも改善できる。

【００４７】さらに、本実施の形態においては、上記構成の対向保護板１１に切断ブロック８と並列保護板９を接着するため、ギャップ平行度は問題とならず、複合型磁気ヘッドの製造が容易となる。

【００４８】以上、本実施の形態では、磁気ヘッドが３つ組み合わされて構成された複合型磁気ヘッドを用いて説明したが、本発明は、これに限定されるものではないことは言うまでもない。また、本実施の形態では、少なくとも薄膜ヘッド素子と電極引き出し端子を有する薄膜磁気ヘッド基板とこの薄膜磁気ヘッド基板を保護する対向保護基板とからなる磁気ヘッドを含むものであれば広く適用されるものである。

【００４９】

【発明の効果】本発明の複合型磁気ヘッドの製造方法は、櫛歯状に形成された対向保護基板が接合された薄膜磁気ヘッド基板を１チップに切り出すことで、複合型磁気ヘッドを構成することとなる磁気ヘッド部が作製されるために、従来の切断基準位置マーカ確認用溝入れと電極引き出し端子を露出させるための切断が不要となり、加工効率の改善による製造時間の短縮化、生産性の向上、コストダウンが図られる。

【００５０】さらに、本発明の複合型磁気ヘッドの製造方法は、対向保護基板が接合された薄膜磁気ヘッド基板を切断すると、電極引き出し端子上が解放されるとともに、各切断チップは対向保護板の一方側面部を残して切断されるために、このように製造された磁気ヘッド部を有する複合型薄膜磁気ヘッドを組み合わせる場合、対向保護板の一方側面部が残されているために、隣接する磁気ヘッド部側の面積が大きくなり、組立状態が安定化することになる。したがって、複合型磁気ヘッドの組立強度と組立精度の向上が図られるとともに、磁気記録媒体との当たりにばらつきを生じさせることを防止することが可能となる。

【図面の簡単な説明】

【図１】本発明が適用される一実施の形態の複合型磁気ヘッドの製造工程を示す図であり、基板上に複数の薄膜ヘッドを形成して薄膜素子基板を形成する工程を示す斜視図である。

【図２】上記複合型磁気ヘッドの製造工程を示す図であり、薄膜素子基板を切断して形成される切断ブロックを示す斜視図である。

【図３】上記複合型磁気ヘッドの製造工程を示す図であり、薄膜素子基板、並列保護板、及び対向保護板を接着する状態を示す斜視図である。

【図４】上記複合型磁気ヘッドの製造工程を示す図であり、接着ブロックを各チップに切断する状態を示す斜視図である。

【図５】上記複合型磁気ヘッドの製造工程を示す図であり、接着ブロックを各チップに切断する状態を示す斜視図である。

【図６】上記複合型磁気ヘッドの製造工程を示す図であり、各チップに磁気記録媒体摺動面を形成して研磨チップを作製した状態を示す斜視図である。

【図７】上記複合型磁気ヘッドの製造工程を示す図であり、研磨チップに印刷配線基板を接続して形成されるヘッドチップを示す斜視図である。

【図８】上記複合型磁気ヘッドの製造工程を示す図であり、薄膜磁気ヘッドチップを有する複合型磁気ヘッドを組み立てた状態を示す斜視図である。

【図９】複数のヘッドチップが側面基準板に当接し加圧された状態を示す模式図である。

【図１０】従来の複合型磁気ヘッドの製造工程を示す図であり、基板上に複数の薄膜磁気ヘッドを形成して薄膜ヘッド素子基板を形成する工程を示す斜視図である。

【図１１】従来の複合型磁気ヘッドの製造工程を示す図であり、薄膜ヘッド素子基板を切断して形成される切断ブロックを示す斜視図である。

【図１２】従来の複合型磁気ヘッドの製造工程を示す図であり、薄膜ヘッド素子基板、並列保護板、及び対向保護板を接着する状態を示す斜視図である。

【図１３】従来の複合型磁気ヘッドの製造工程を示す図であり、接着ブロックを各チップに切断する状態を示す斜視図である。

【図１４】従来の複合型磁気ヘッドの製造工程を示す図であり、接着ブロックを各チップに切断した状態を示す斜視図である。

【図１５】従来の複合型磁気ヘッドの製造工程を示す図であり、チップに磁気記録媒体摺動面を形成して研削チップを作製した状態ををを示す斜視図である。

【図１６】上記複合型磁気ヘッドの製造工程を示す図であり、研削チップに印刷配線基板を接続して形成されるヘッドチップを示す斜視図である。

【図１７】上記複合型磁気ヘッドの製造工程を示す図であり、薄膜磁気ヘッドチップを有する複合型磁気ヘッドを組み立てた状態を示す斜視図である。

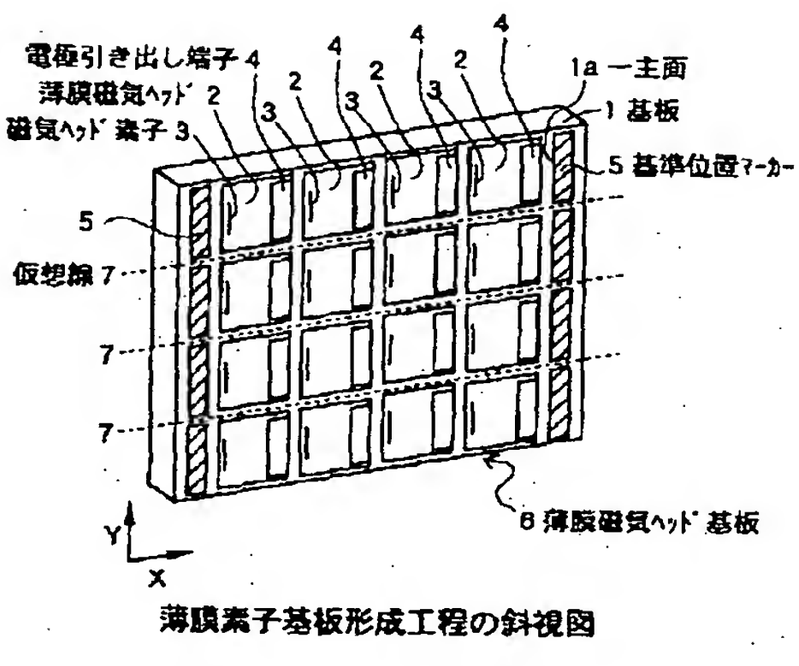
【図１８】複数のヘッドチップが側面基準板に当接し加圧された状態を示す模式図である。

【符号の説明】

１，１Ａ，１Ｂ，１Ｃ　ヘッドチップ、　３　薄膜ヘッ

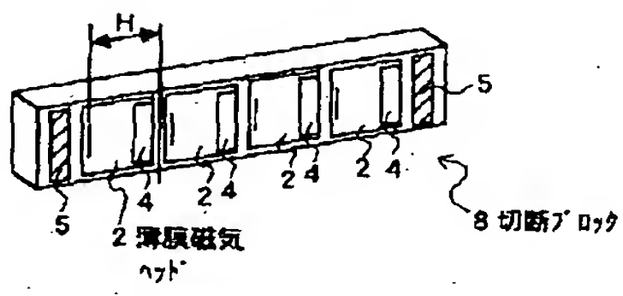
ド素子、　４　電極引き出し端子、　１１　対向保護板、　１１ａ　対向保護板の一方側面側、　１１ｂ　対向保護板の他方側面側、　１３　凹状の開口、　１０　接着ブロック、２１　複合型磁気ヘッド

【図１】



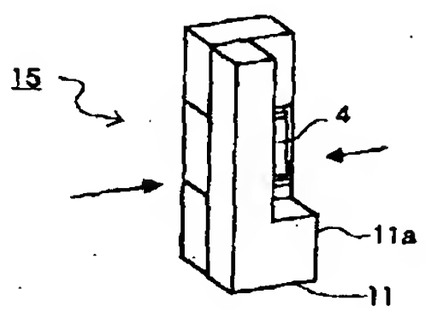
薄膜素子基板形成工程の斜視図

【図２】

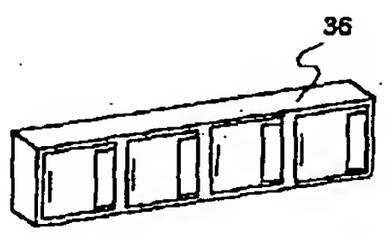


切断した薄膜素子基板の斜視図

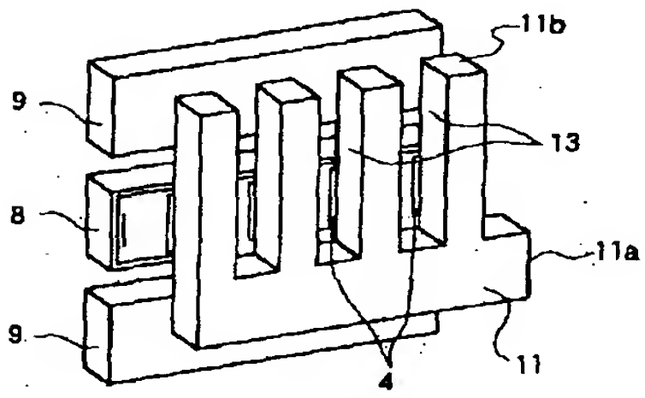
【図５】



【図１１】



【図３】



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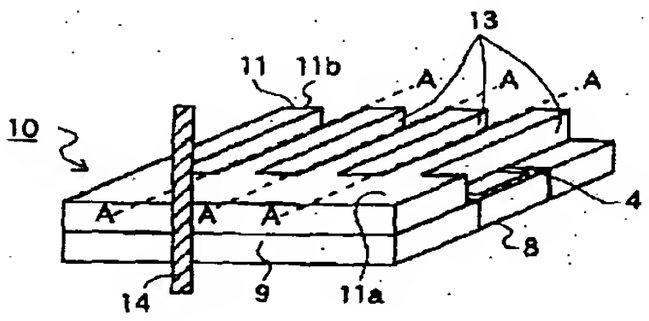
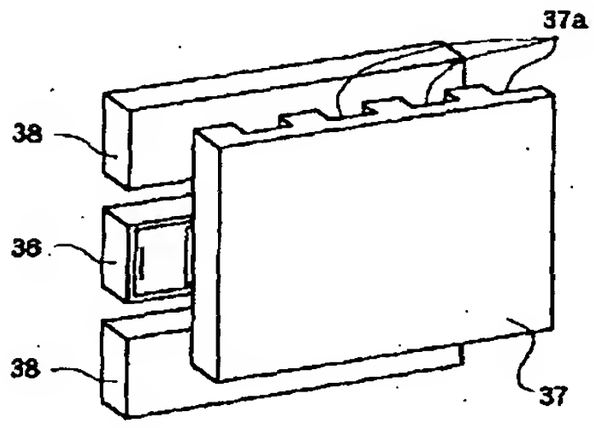
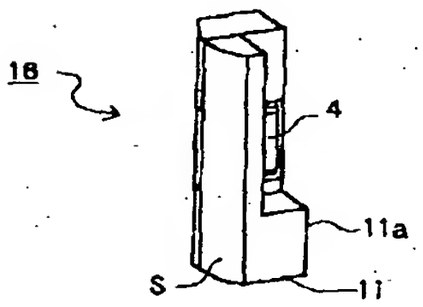


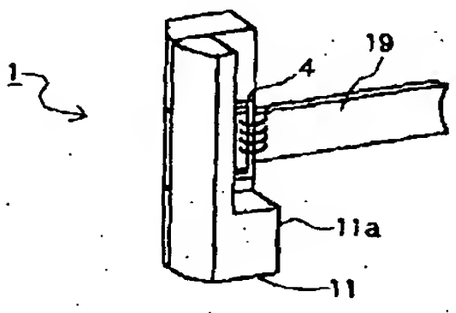
【図１２】



【図７】

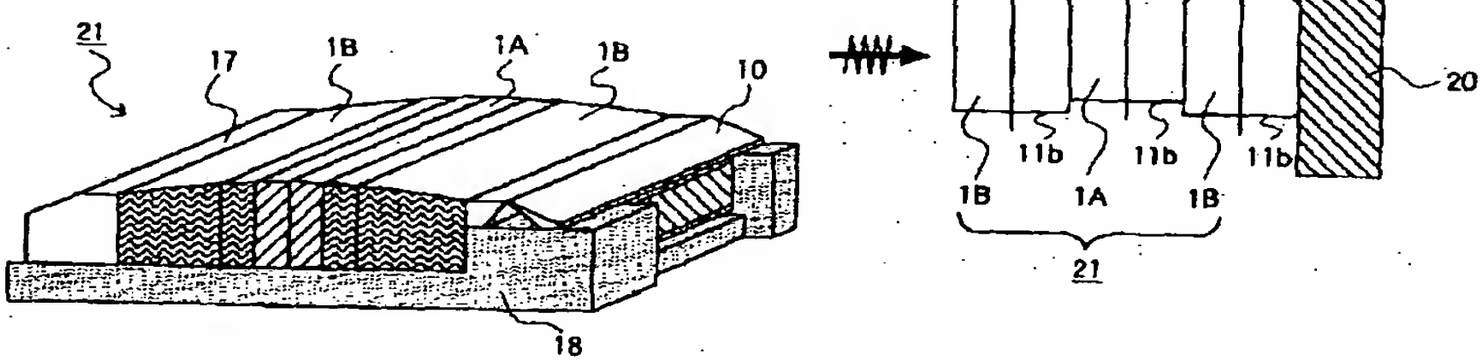
【図６】



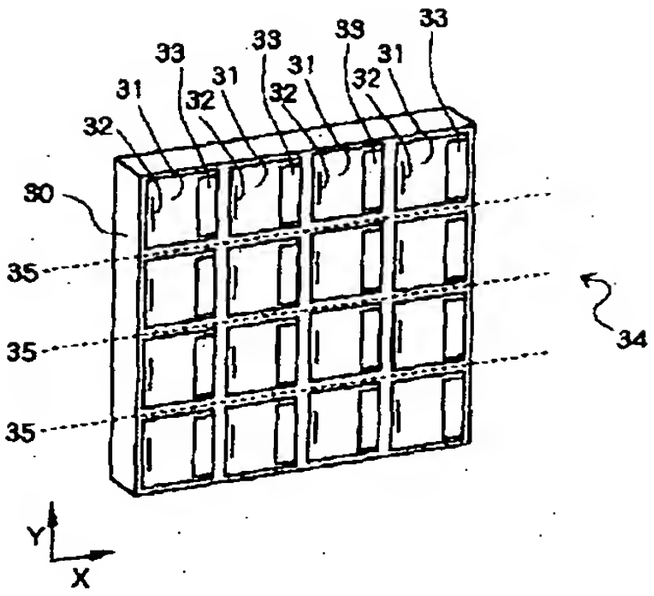


【図９】

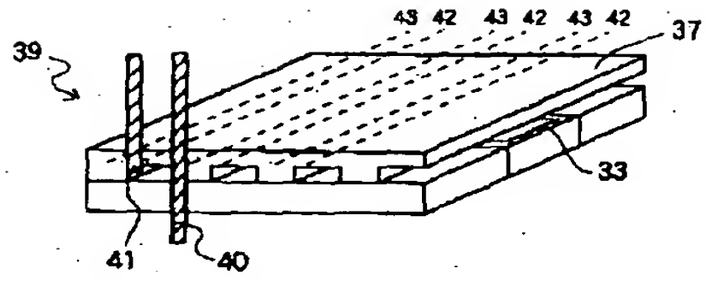
【図８】



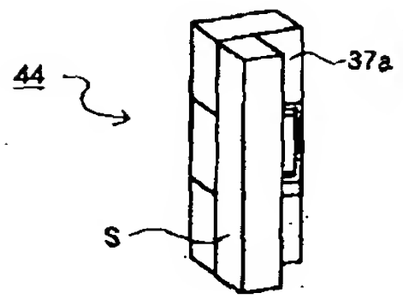
【図１０】



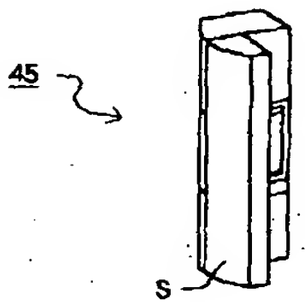
【図１３】



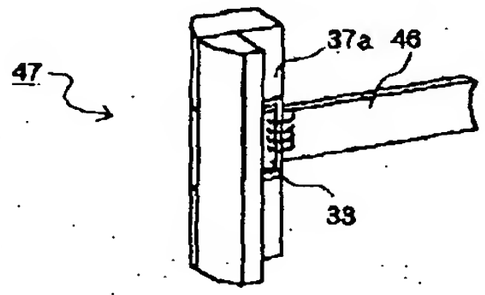
【図１４】



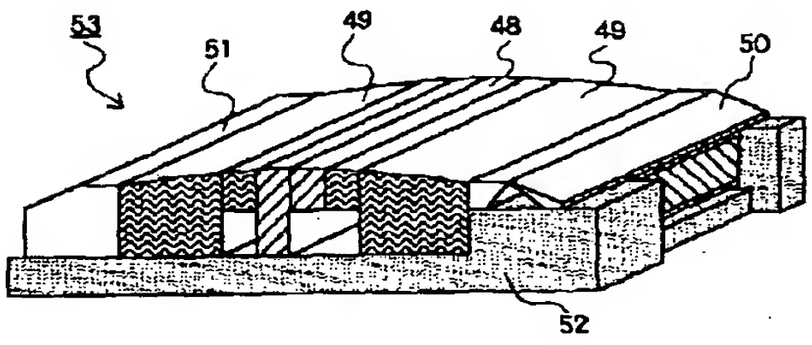
【図１５】



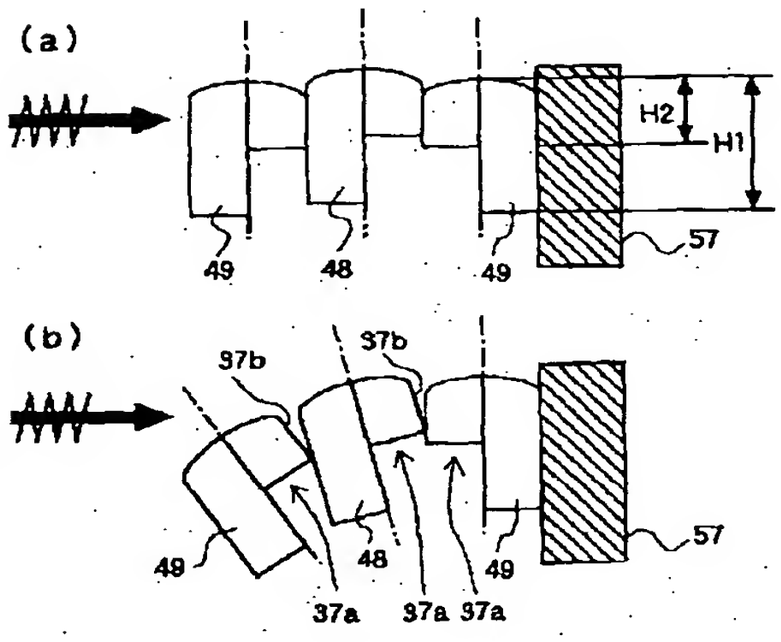
【図１６】



【図１７】



【図１８】



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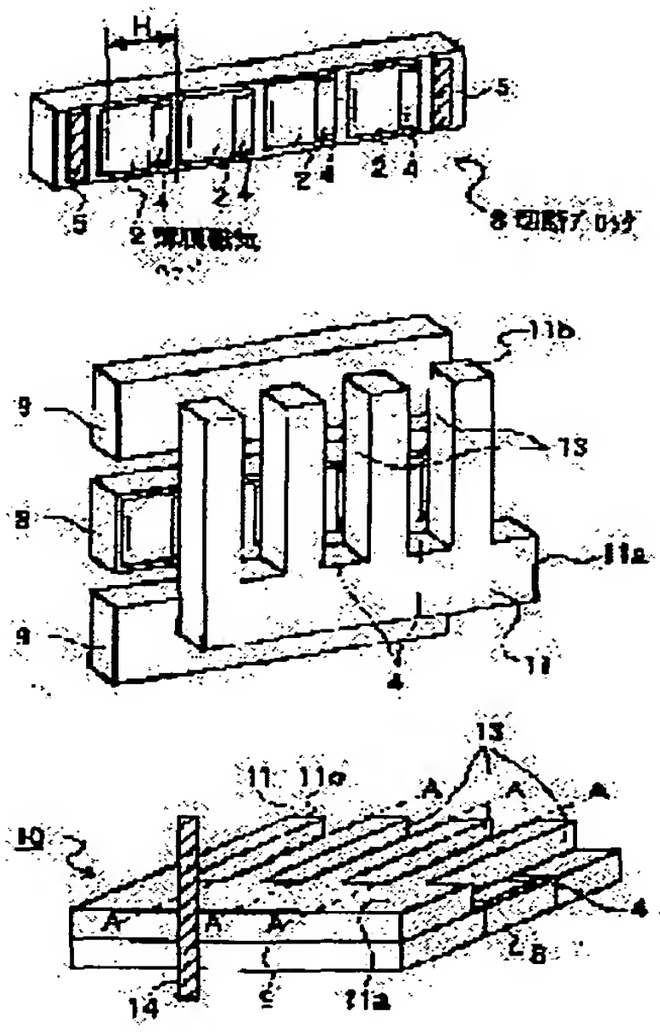
(21)Application number : 08-191263
(22)Date of filing : 19.07.1996

(71)Applicant : SONY CORP
(72)Inventor : YAMAZAKI MASAHIKO

(54) MANUFACTURE OF COMPOSITE TYPE MAGNETIC HEAD

(57)Abstract:
PROBLEM TO BE SOLVED: To improve accuracy and strength of assembly to minimize the number of processing steps in order to realize highly efficient manufacture by forming a comb-tooth type protection plate which is provided opposed to a thin film magnetic head substrate with the other side surface being opened leaving one side surface.
SOLUTION: With bonding of a parallel protection plate 9 functioning as a sliding section with a magnetic recording medium and an opposing protection plate 11, a bonding block 10 has a medium sliding section in which the width in the track width direction of a thin film magnetic head 2 is wider than the head 2. The opposing protection plate 11 allows formation of a recessed aperture 13 opening an electrode leading terminal 4 toward the other side surface 11b, leaving one side surface 11a. Therefore, even after the bonding of a cutout block 8 and the opposing protection plate 11, since a cutting position marker 5 and electrode leading terminal 4 are exposed from the recessed aperture 13, work alignment can be made immediately.



LEGAL STATUS

[Date of request for examination]

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[Date of final disposal for application]

[Patent number]

[Date of registration]

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[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

CLAIMS

[Claim(s)]
[Claim 1] The manufacture method of the compound-die magnetic head characterized by providing the following. The process which forms the thin film magnetic-head substrate which comes to carry out two or more array formation in the direction in which a magnetic-recording medium sliding surface and the thin-film-head element which has an electrode drawer terminal cross at right angles. The process which forms the opposite protective-group board which counters the above-mentioned thin film magnetic-head substrate, and is arranged in the shape of [which leaves the one side side side / by which an other side side side is used as concave opening] a ctenidium. The process which joins the above-mentioned opposite protective-group board to the above-mentioned thin film magnetic-head substrate. The process which cuts the thin film magnetic-head substrate to which the above-mentioned opposite protective-group board was joined, and is divided into each magnetic-head section, and process which arranges two or more magnetic-head sections in the magnetic-recording medium run direction, and carries out junction unification .

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention is carried in the magnetic recorder and reproducing device of for example, the data cartridge for computers etc. recordable high-density, and relates to the manufacture method of the suitable compound-die magnetic head.

[0002]
[Description of the Prior Art] In fields, such as a tape streamer for the computers by which the thin film magnetic head suitable for high-density magnetic recording is shifting to high capacity-ization more, adoption-ization is advanced instead of the bulk type magnetic head.
[0003] More, an inductive head is used as a head for record, and the magnetoresistance-effect type magnetic head (an MR head is called hereafter.) which changes the signal magnetic field from a magnetic-recording medium into electric resistance change, and is detected is used as a head for reproduction by the correspondence to densification especially in recent years.
[0004] Generally this thin film magnetic head is made with the composition equipped with the element substrate in which two or more thin-film-head elements which have an electrode drawer terminal were formed, the opposite guard plate which counters this element substrate and is allotted, and the parallel guard plate with which the sliding section with the magnetic-recording medium of the above-mentioned element substrate is compensated.
[0005] In the direction of the width of recording track of this thin-film-head element, the above-mentioned element substrate and the opposite guard plate were made as it is broad, and they have secured the hit property with a magnetic-recording medium from a thin-film-head element. Moreover, an opposite guard plate protects a thin-film-head element, and the exposure slot for wirebonding or solder connection is widely formed in the unilateral side in the position corresponding to the position of an electrode drawer terminal.
[0006] Use is presented with it, two or more thin film magnetic heads in the combination of the thin film magnetic head which has the thin film magnetic head which has an inductive head, and an MR head pasting up if needed [the], and such the thin film magnetic head being used as the compound-die magnetic head.
[0007] by the way, the magnetic thin film which faces manufacturing the thin film magnetic head (an MR head being included) which constitutes such the compound-die magnetic head, and constitutes the magnetic-circuit section like a semiconductor integrated circuit and a conductor — since a coil etc. is created using technique, such as vacuum thin film coating technologies, such as vacuum evaporationo and sputtering, and photoengraving process, etching, generally it is created in many cases in the substrate size of about 3-5 inches
[0008] Occupancy area on the substrate which formation of each thin-film-head element takes while enlarging substrate size as much as possible in order to reduce the number of processes which per 1 in the thin film morphosis head takes like the case of a semiconductor integrated circuit, and to earn the yield per one head and to aim at a cost cut is made small to necessary minimum here, and it is necessary to make it the number of the heads which can be taken from per element substrate of the same area increase as much as possible.
[0009] Since the area which the margin portion which does not have a thin-film-head element in the thin film magnetic head which needs the sliding section with the latus magnetic-recording medium of width of face, for example, the thin film magnetic head used for the tape streamer for computers, rather than a thin-film-head element occupies increases, it will become impossible however, to make [many] the number of heads into which it is put in the element substrate which is. In such the thin film magnetic head, a thin film formation process causes a cost rise from dozens of or more processes and there being very many rates in the inside of the whole number of processes for which it accounts in many cases as a result from a viewpoint of the yield.
[0010] Conventionally, in order to avoid an above-mentioned problem in this thin film magnetic head, the method of pasting up the parallel guard plate with which sliding width of face with the magnetic-recording medium which needs the width-of-face size for one head for the ends side of the direction of the width of recording track of an element substrate in which the thin-film-head element was formed is compensated, and the opposite guard plate which protects the above-mentioned thin-film-head element at a next process is taken.
[0011] That is, the above-mentioned thin film magnetic head is manufactured by the following manufacture methods.
[0012] First, as shown, for example in drawing 10 , the thin film magnetic head 31 is first formed in the front face of a substrate 30 in the shape of a matrix using thin film coating technologies, such as vacuum evaporationo, sputtering, or etching, and the thin film magnetic-head substrate 34 is produced. The thin-film-head element 32 and the electrode drawer terminal 33 from this thin-film-head element 32 are formed in this thin film magnetic head 31.
[0013] Next, the above-mentioned thin film magnetic-head substrate 34 is cut along with the imaginary line 35 shown by the drawing 10 middle point line, and the cutting block 36 as shown in drawing 11 is produced.
[0014] Subsequently, as shown in drawing 12 , the cutting block 36 is combined with the opposite guard plate 37 and the parallel guard plate 38, and it pastes up with a resin or glass. Thereby, the adhesion block 39 as shown in drawing 13 is produced.
[0015] Here, cross-section **** KO character-like exposure slot 37a sets a fixed interval, and two or more opposite protective-group boards 37 are formed in the adhesion-with the cutting block 36 side, as the thin-film-head element 32 of the thin film magnetic head 31 is protected and it is shown in drawing 12 . This exposure slot 37a is formed in the position corresponding to the position of the electrode drawer terminal 33 of the thin film magnetic-head substrate 34 as a slot which penetrates the both-sides side of the opposite protective-group board 37.
[0016] Next, as shown in drawing 13 , it cuts along with an imaginary line 42 and an imaginary line 43. That is, in order to cut along with an imaginary line 42 by the grinding stone 40, and to start for one chip first, next to expose the electrode drawer terminal 33, along with an imaginary line 43, it cuts by the grinding stone 41.
[0017] Thus, cutting produces the cutting chip 44 with which exposure slot 37a to which the electrode drawer terminal 33 is exposed was formed greatly, as shown in drawing 14 .
[0018] After that, it controls and grinds so that it may become the depth-of-gap size defined beforehand using the polish monitor (a depth

monitor is called hereafter.) which detects the amount of depth-of-gap polishes in which the magnetic-recording medium sliding surface S was formed in the thin film magnetic-head substrate 34 by change of the marker (a depth marker is called hereafter.) and electric resistance which are read with a size, and the grinding chip 45 as shown in drawing 15 is produced.
[0019] Subsequently, as shown in drawing 16 , electrode wiring is taken out from the electrode drawer terminal 33 of the grinding chip 45 using wire bonding or solder connection to the printed wiring substrate 46, and the head chip 47 is produced.
[0020] Next, as shown in drawing 17 , it positions in the shield frame 52 which consists of a permalloy etc. combining the magnetic-head chip 48 for record with which the magnetic-head element for record was formed among the head chips 47 formed as mentioned above, the magnetic-head chip 49 for reproduction of a couple with which the magnetic-head element for reproduction was formed, the magnetic-head chip 50 for elimination with which the magnetic-head element for elimination was formed, and a tape guide 51, and fixes by the resin etc. Thereby, the compound-die magnetic head 53 is produced.
[0021]
[Problem(s) to be Solved by the Invention] By the way, although use is presented with the magnetic-head chip 48 for record, and the magnetic-head chip 49 for reproduction of a couple as the compound-die magnetic head 53 by which junction unification was carried out, in the above-mentioned conventional compound-die magnetic head 53, un-arranging, as shown below produces them.
[0022] That is, when producing the compound-die magnetic head 53 shown in drawing 17 , various positioning is performed combining head chips. In case tilt adjustment shown in drawing 18 in it is performed, since the thickness precision of the cutting chip of each head chips 48 and 49, the opposite guard plate 37, and the parallel guard plate 38 is acquired, it usually adjusts by pressurizing each head chip 48 and 49 comrades in contact with the side orientation plate 57. However, since the height size H2 of the opposite guard plate of each head chips 48 and 49 is short compared with a cutting chip and the height size H1 of a parallel guard plate by the size to which the electrode drawer terminal 33 of a thin-film-head element is exposed at this time, when contacting and pressurizing, the problem was in stability when it is easy to open to a flabellate and adjusts to it.
[0023] Moreover, all the back end sides of the opposite protective-group board 37 were removed, and each head chips 48 and 49 have pasted up the thin film magnetic-head substrate 34 and the opposite protective-group board 37 only by the upper part side of exposure slot 37a. Therefore, since its area of adhesion side 37b with the adjoining thin film magnetic head is small even if the opposite protective-group board 37 carries out junction unification by the conventional manufacture method, gap tended to produce it in the adhesion side of head chips. If such gap arises, the plumbness during each head chip will not be kept exact, but will become the cause of making the hit by the magnetic-recording medium producing dispersion.
[0024] Furthermore, by the conventional manufacture method, since the cutting criteria position marker beforehand formed in the thin film magnetic head is hidden by the opposite guard plate 37 when cutting the adhesion block 39 along with an imaginary line 42 by the grinding stone 40 as shown in drawing 13 , grooving for a cutting criteria position marker check is carried out, and alignment of the adhesion block 39 must be recarried out. Furthermore, in order also to have to perform cutting for exposing the electrode drawer terminal 33 along with an imaginary line 43 by the grinding stone 41, a processing process increases and processing efficiency is bad.
[0025] Then, this invention makes it a technical problem to offer the manufacture method of the compound-die magnetic head that it can be proposed in view of this Prior-art-technical problem, the compound-die magnetic head by which improvement in the assembly precision at the time of an assembly and intensity is achieved can be held down to the minimum, and the number of processing processes can be manufactured efficiently.
[0026]
[Means for Solving the Problem] The process which forms the thin film magnetic-head substrate which comes to carry out two or more array formation in the direction in which a magnetic-recording medium sliding surface and the thin-film-head element which has an electrode drawer terminal cross at right angles in order that the compound-die magnetic head of this invention may solve the above-mentioned technical problem, The process which forms the opposite protective-group board which counters the above-mentioned thin film magnetic-head substrate, and is arranged in the shape of [which leaves the one side side side / by which an other side side side is used as concave opening] a ctenidium, The process which joins the above-mentioned opposite protective-group board to the above-mentioned thin film magnetic-head substrate, and the thin film magnetic-head substrate to which the above-mentioned opposite protective-group board was joined are cut. It is characterized by having the process divided into each magnetic-head section, and the process which arranges two or more magnetic-head sections in the magnetic-recording medium run direction, and carries out junction unification.
[0027] In order to form an opposite guard plate in the shape of [which leaves the one side side side / by which an other side side side is used as concave opening] a ctenidium according to this invention, after starting for one chip like before, cutting for making it open [begin] becomes unnecessary about an electrode drawer terminal further.
[0028] And if the thin film magnetic-head substrate to which the opposite protective-group board was joined is cut, while an electrode drawer terminal top will be released, each cutting chip leaves the one side lateral portion of an opposite guard plate, and is cut. Therefore, when producing combining the compound-die thin film magnetic head which has the thin film magnetic head manufactured in this way, since [of an opposite guard plate] the lateral portion is left behind on the other hand, the area by the side of the adjoining magnetic-head section becomes large, and an assembly state is stable.
[0029]
[Embodiments of the Invention] It explains in detail, referring to a drawing hereafter about the gestalt of the concrete operation which applied this invention.
[0030] The gestalt of this operation describes the example which applied this invention to the manufacture method of the thin film magnetic head of the compound die which pasted up the thin film magnetic head which has a head for record, the thin film magnetic head which has a head for reproduction, and the thin film magnetic head which has a head for elimination.
[0031] In the manufacture method of the compound-die magnetic head of the gestalt this operation, as first shown in drawing 1 , it forms in the direction of the width of recording track of the above-mentioned thin film magnetic head 2 shown by the direction which intersects perpendicularly with the magnetic-recording medium sliding surface which uses thin film coating technologies, such as vacuum evaporationo, sputtering, or etching, for 1 principal-plane 1a of a substrate 1, and shows the thin film magnetic head 2 by the arrow X in drawing, and the arrow Y in drawing in the shape of a matrix.
[0032] Here, the electrode drawer terminal 4 from the magnetic-head element 3 and this magnetic-head element 3 is formed in the above-mentioned thin film magnetic head 2.
[0033] Moreover, two or more criteria position markers 5 shown in the slash section in drawing according to the formation position of this thin film magnetic head 2 are formed in the portion in which it is the ends of the direction of X of the above-mentioned substrate 1, and the above-mentioned thin film magnetic head 2 is not formed simultaneously, and the thin film magnetic-head substrate 6 is produced into it.
[0034] And it cuts along with the imaginary line 7 shown by the drawing middle point line which makes a perpendicular direction (the direction of X) to the direction of a field (the direction of Y) which serves as a sliding surface which finally touches magnetic-recording media (magnetic

tape etc.) in the above-mentioned thin film magnetic-head substrate 6.
[0035] Thereby, as shown in drawing 2 , array formation of the thin film magnetic head 2 of plurality (here four) is carried out in the direction of X, i.e., the direction which intersects perpendicularly with the above-mentioned magnetic-recording medium sliding surface, and the above-mentioned thin film magnetic-head substrate 6 is divided by the cutting block 8 with which the criteria position marker 5 is formed in the ends of the direction of X.
[0036] Subsequently, as shown in drawing 3 , the opposite guard plate 11 formed the cutting block 8, the parallel guard plate 9, and in the shape of a ctenidium is combined, and it pastes up with a resin or glass. Thereby, the adhesion block 10 as shown in drawing 4 is produced. That is, the adhesion block 10 serves as the composition of having the medium sliding section with the width of face of the direction of the width of recording track of the thin film magnetic head 2 broader than this thin film magnetic head 2, by adhesion with the parallel guard plate 9 and the opposite guard plate 11 which function as the sliding section with a magnetic-recording medium.
[0037] As for the above-mentioned opposite guard plate 11, the whole configuration comes to present the shape of a ctenidium here. That is, this opposite guard plate 11 leaves one side side side 11a, and the concave opening 13 which releases the electrode drawer terminal 4 to other side side side 11b is formed. Therefore, since the cutting position marker 5 and the electrode drawer terminal 4 will expose after adhesion with the cutting block 8 and the opposite guard plate 11 from the concave opening 13, work alignment can be performed immediately.
[0038] Next, the cutting chip 15 as shown in drawing 5 is produced by cutting along with imaginary line A-A in drawing 4 by the grinding stone 14, and starting for one chip. It cuts using the criteria position marker 5 mentioned above in the case of this cutting.
[0039] Here, since the above-mentioned opposite guard plate 11, on the other hand, leaves lateral portion 11a and is formed, the part of the same thickness is formed in a back side side from a magnetic-recording medium sliding-surface side at one side of the parallel guard plate 9.
[0040] This point and the conventional manufacture method had taken the process of removal altogether the back end side of an opposite protective-group board further after that, while cutting from the electrode drawer terminal side of a thin film formation substrate first for every chip, in order to remove the opposite protective-group board on an electrode drawer terminal (refer to drawing 13). However, at such a cutting process, a cutting man day cuts in many. This becomes more remarkable, as the number of the thin-film-head elements 3 which follow the thin film magnetic-head substrate 2, and are allotted increases.
[0041] On the other hand, after facing the manufacture method of the gestalt this operation cutting the above-mentioned adhesion block 10 for each cutting chip 15, being sufficient for it if it cuts from the opening perpendicular side behind the above-mentioned concave opening 13 (the inside of drawing 4 , A-A line), and starting it for one chip like before, it becomes unnecessary further cutting it for exposing the electrode drawer terminal 4. And since [of the opposite guard plate 11] lateral portion 11b is left behind on the other hand, the area by the side of the adjoining magnetic head can become large, and an assembly state can be stabilized.
[0042] After that, the magnetic-recording medium sliding surface S in this cutting chip 15 is controlled to become the depth-of-gap size defined beforehand using a depth marker, a depth monitor, etc. which are used conventionally, grinding wrapping of two or more cutting chips 15 is carried out simultaneously, and the grinding chip 16 as shown in drawing 6 is produced.
[0043] It is necessary to control the depth of the above-mentioned thin film magnetic head 2 by precision of several micrometers at this time. Then, while an above-mentioned depth marker and an above-mentioned depth monitor are formed and this checks the amount of grinding of the direction of a depth at the same time it forms the thin film magnetic head 2 on a substrate 1 as mentioned above, the variation in the depth of the cutting chip 15 is suppressed, and the whole processing man day is stopped.
[0044] Subsequently, electrode wiring is taken out from this grinding chip 16 from the electrode drawer terminal 4 of the thin-film-head element 3 using wire bonding or solder connection to the printed wiring substrate 19, and the head chip 1 as shown in drawing 7 is produced.
[0045] Next, as shown in drawing 8 , it positions in thin film magnetic-head chip 1A in which the magnetic-head element for record was formed among the above-mentioned head chips 1, thin film reproducing-head chip 1B of the couple in which the magnetic-head element for reproduction was formed, elimination magnetic-head chip 1C, and the shield frame 18 that consists of a permalloy etc. combining a tape guide 17 etc., and fixes by the resin etc. Thereby, the compound-die magnetic head 21 is produced.
[0046] As the compound-die magnetic head 21 assembled by carrying out such is shown in drawing 9 , since [of the opposite guard plate 11] lateral portion 11a is left behind on the other hand, as for each head chips 1A and 1B, the part where the height of the parallel guard plate 9 and the opposite guard plate 11 is the same is established. Therefore, even if it pressurizes in contact with the side orientation plate 20, it does not open to a sector like before. Moreover, the yield is also improvable, while connection of wire bonding etc. is improved, since the opposite guard plate 11 is formed in the shape of a ctenidium.
[0047] Furthermore, in the gestalt of this operation, in order to paste up the cutting block 8 and the parallel guard plate 9 on the opposite guard plate 11 of the above-mentioned composition, gap parallelism does not pose a problem but it becomes easy to manufacture [of the compound-die magnetic head] it.
[0048] As mentioned above, this invention cannot be overemphasized by that it is not what is limited to this although explained using the compound-die magnetic head by which the three magnetic heads were put together and constituted from a gestalt of this operation. Moreover, with the gestalt of this operation, if the magnetic head which consists of a thin film magnetic-head substrate which has a thin-film-head element and an electrode drawer terminal at least, and an opposite protective-group board which protects this thin film magnetic-head substrate is included, it will be applied widely.
[0049]
[Effect of the Invention] The manufacture method of the compound-die magnetic head of this invention is starting the thin film magnetic-head substrate to which the opposite protective-group board formed in the shape of a ctenidium was joined for one chip. Since the magnetic-head section which will constitute the compound-die magnetic head is produced, cutting for exposing conventional grooving for a cutting criteria position marker check and a conventional electrode drawer terminal becomes unnecessary, and shortening of the production time by improvement of processing efficiency, improvement in productivity, and a cost cut are achieved.
[0050] Furthermore, the manufacture method of the compound-die magnetic head of this invention If the thin film magnetic-head substrate to which the opposite protective-group board was joined is cut, while an electrode drawer terminal top will be released Each cutting chip since [of an opposite guard plate] it leaves a lateral portion on the other hand and is cut Thus, when combining the compound-die thin film magnetic head which has the manufactured magnetic-head section, since [of an opposite guard plate] the lateral portion is left behind on the other hand, the area by the side of the adjoining magnetic-head section becomes large, and an assembly state will be stable. Therefore, while improvement in the assembly intensity of the compound-die magnetic head and assembly precision is achieved, it becomes possible to prevent making the hit by the magnetic-recording medium produce dispersion.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is drawing showing the manufacturing process of the compound-die magnetic head of the gestalt of the 1 operation to which this invention is applied, and is the perspective diagram showing the process which forms two or more thin film heads, and forms a thin-film substrate on a substrate.
[Drawing 2] It is drawing showing the manufacturing process of the above-mentioned compound-die magnetic head, and is the perspective diagram showing the cutting block which cuts a thin-film substrate and is formed.
[Drawing 3] It is drawing showing the manufacturing process of the above-mentioned compound-die magnetic head, and is the perspective diagram showing the state of pasting up a thin-film substrate, a parallel guard plate, and an opposite guard plate.
[Drawing 4] It is drawing showing the manufacturing process of the above-mentioned compound-die magnetic head, and is the perspective diagram showing the state of cutting an adhesion block for each chip.
[Drawing 5] It is drawing showing the manufacturing process of the above-mentioned compound-die magnetic head, and is the perspective diagram showing the state of cutting an adhesion block for each chip.
[Drawing 6] It is drawing showing the manufacturing process of the above-mentioned compound-die magnetic head, and is the perspective diagram showing the state where formed the magnetic-recording medium sliding surface in each chip, and the polish chip was produced.
[Drawing 7] It is drawing showing the manufacturing process of the above-mentioned compound-die magnetic head, and is the perspective diagram showing the head chip which connects a printed wiring substrate to a polish chip, and is formed.
[Drawing 8] It is drawing showing the manufacturing process of the above-mentioned compound-die magnetic head, and is the perspective diagram showing the state where the compound-die magnetic head which has a thin film magnetic-head chip was assembled.
[Drawing 9] It is the ** type view showing the state where two or more head chips were pressurized in contact with the side orientation plate.
[Drawing 10] It is drawing showing the manufacturing process of the conventional compound-die magnetic head, and is the perspective diagram showing the process which forms two or more thin film magnetic heads, and forms a thin-film-head element substrate on a substrate.
[Drawing 11] It is drawing showing the manufacturing process of the conventional compound-die magnetic head, and is the perspective diagram showing the cutting block which cuts a thin-film-head element substrate and is formed.
[Drawing 12] It is drawing showing the manufacturing process of the conventional compound-die magnetic head, and is the perspective diagram showing the state of pasting up a thin-film-head element substrate, a parallel guard plate, and an opposite guard plate.
[Drawing 13] It is drawing showing the manufacturing process of the conventional compound-die magnetic head, and is the perspective diagram showing the state of cutting an adhesion block for each chip.
[Drawing 14] It is drawing showing the manufacturing process of the conventional compound-die magnetic head, and is the perspective diagram showing the state where the adhesion block was cut for each chip.
[Drawing 15] It is drawing showing the manufacturing process of the conventional compound-die magnetic head, and is the perspective diagram showing ****** which formed the magnetic-recording medium sliding surface in the chip, and produced the grinding chip.
[Drawing 16] It is drawing showing the manufacturing process of the above-mentioned compound-die magnetic head, and is the perspective diagram showing the head chip which connects a printed wiring substrate to a grinding chip, and is formed.
[Drawing 17] It is drawing showing the manufacturing process of the above-mentioned compound-die magnetic head, and is the perspective diagram showing the state where the compound-die magnetic head which has a thin film magnetic-head chip was assembled.
[Drawing 18] It is the ** type view showing the state where two or more head chips were pressurized in contact with the side orientation plate.

[Description of Notations]
1, 1A, 1B, 1C Head chip 3 Thin-film-head element 4 Electrode drawer terminal 11 Opposite guard plate 11a On the other hand, an opposite guard plate is a side side. 11b Other side side side of an opposite guard plate 13 Concave opening 10 An adhesion block, 21 Compound-die magnetic head

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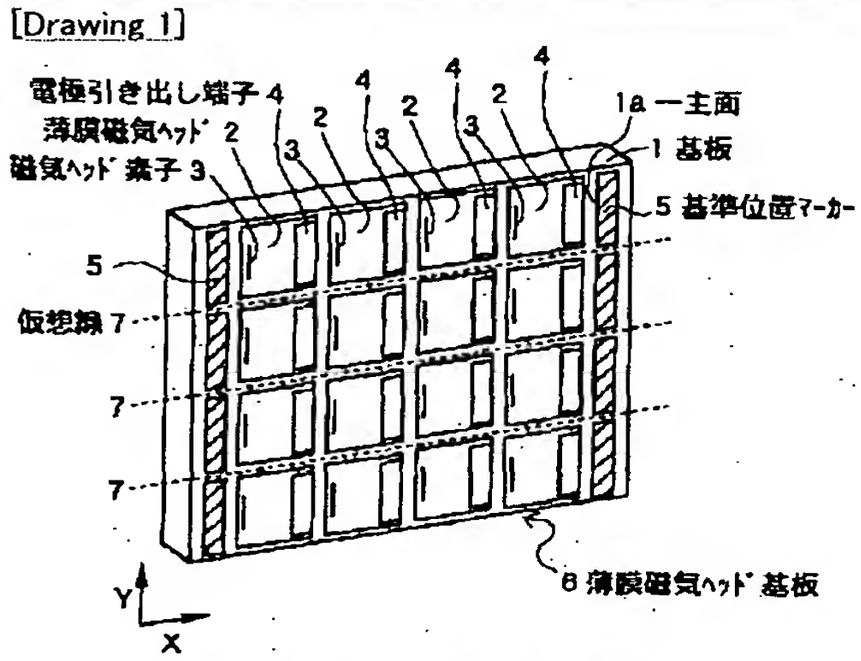
[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

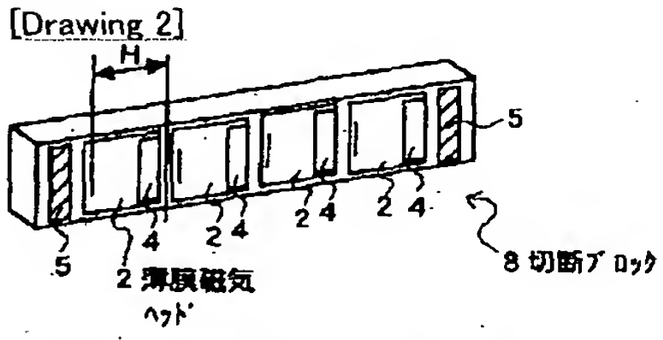
DRAWINGS

[Drawing 1]



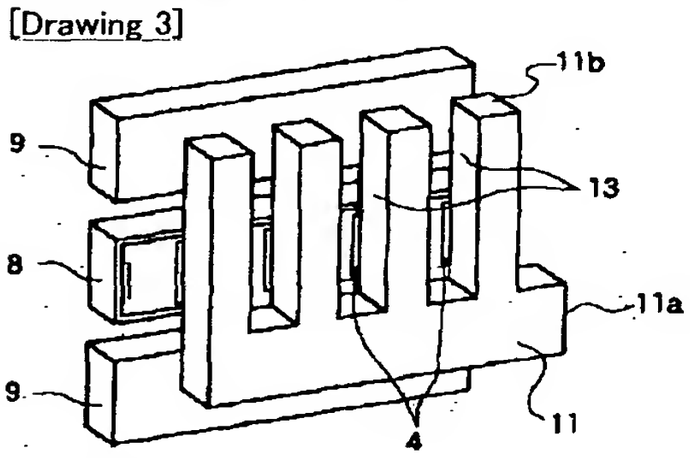
薄膜素子基板形成工程の斜視図

[Drawing 2]

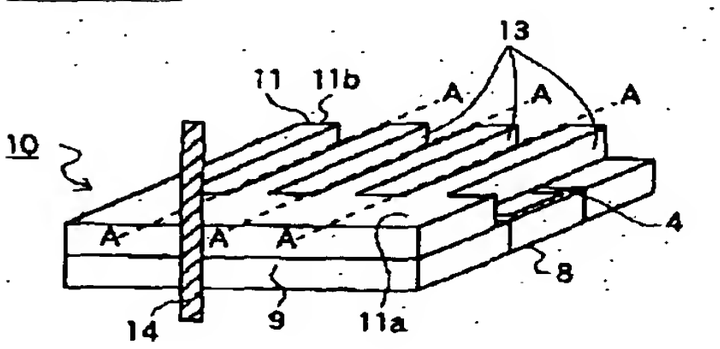


切断した薄膜素子基板の斜視図

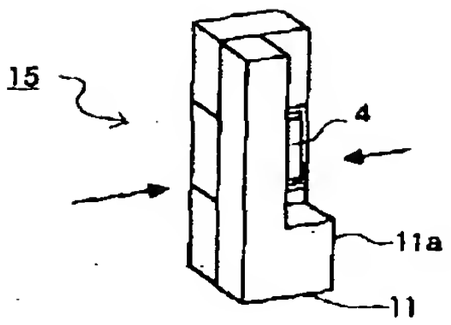
[Drawing 3]



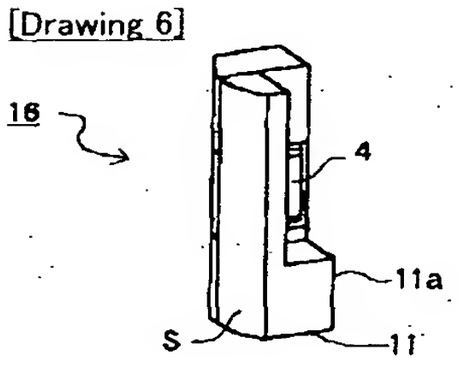
[Drawing 4]



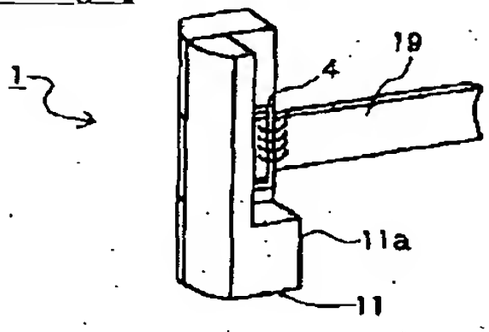
[Drawing 5]



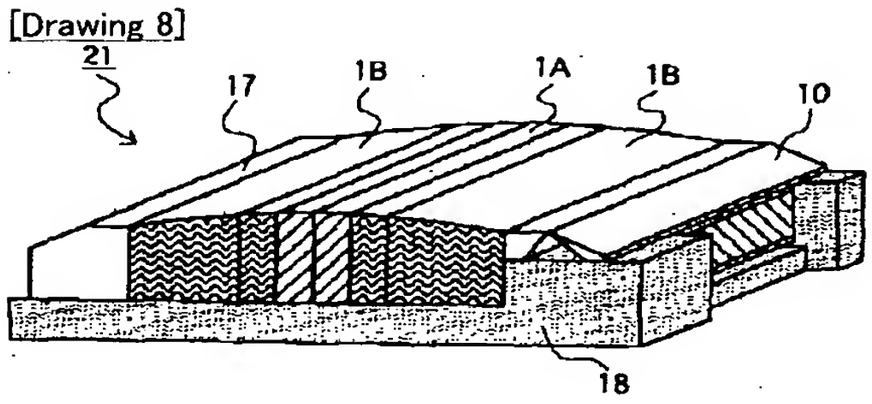
[Drawing 6]



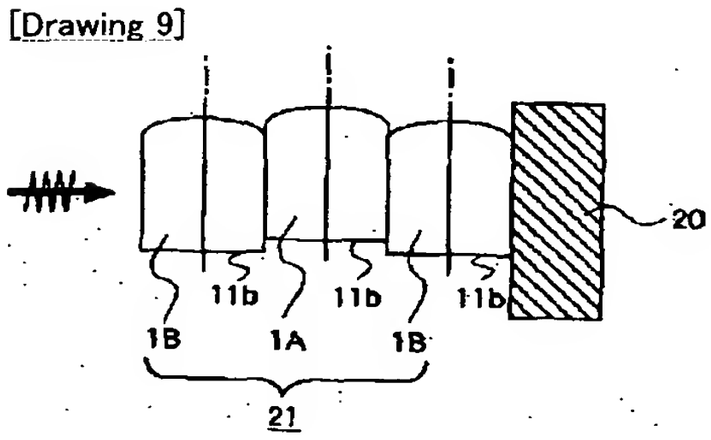
[Drawing 7]



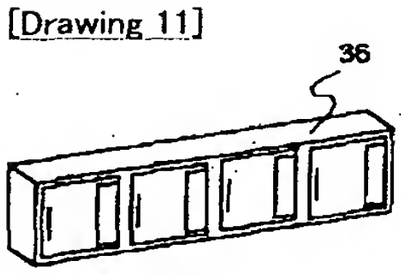
[Drawing 8]



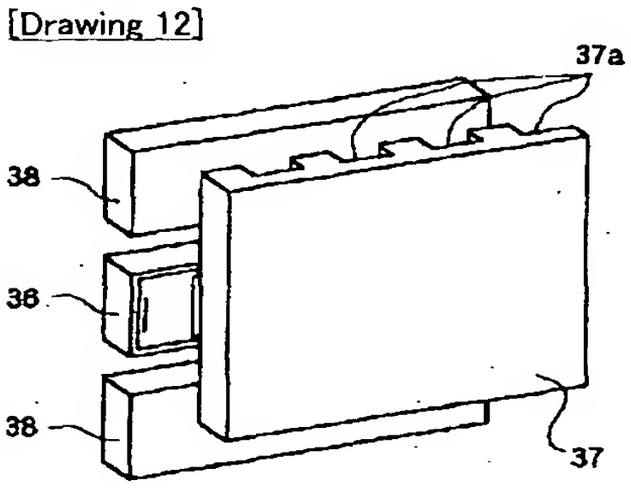
[Drawing 9]



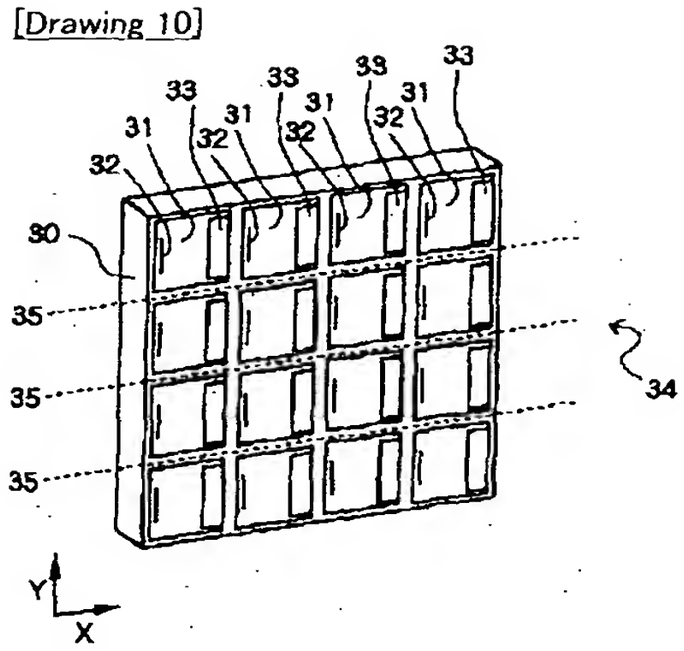
[Drawing 11]



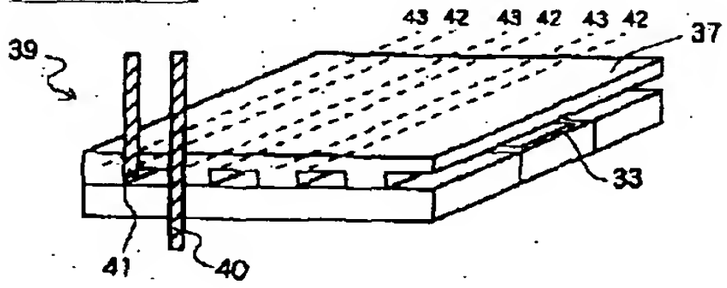
[Drawing 12]



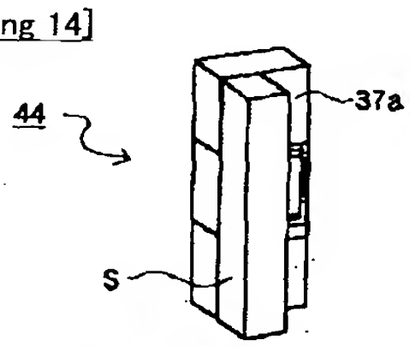
[Drawing 10]



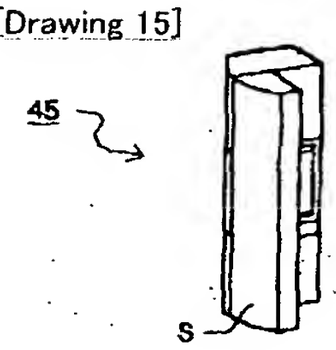
[Drawing 13]



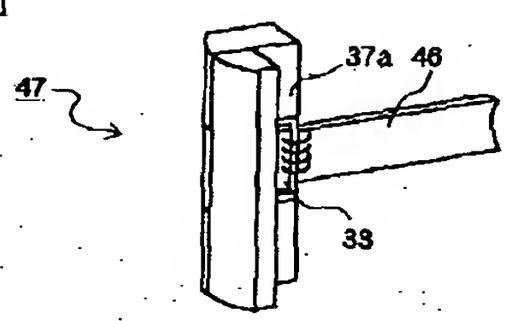
[Drawing 14]



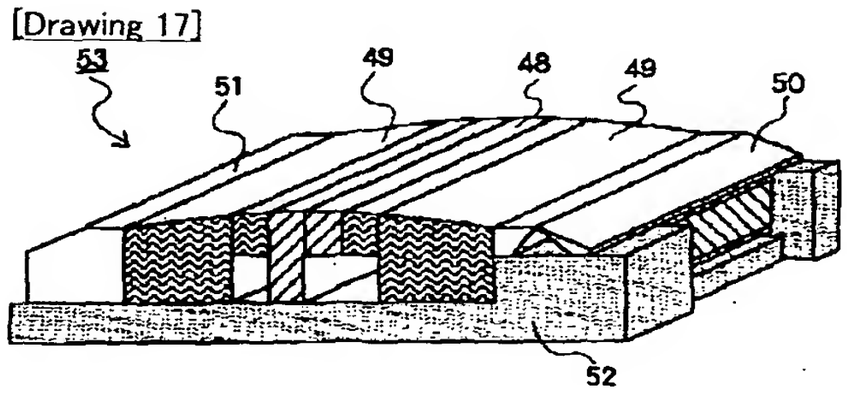
[Drawing 15]



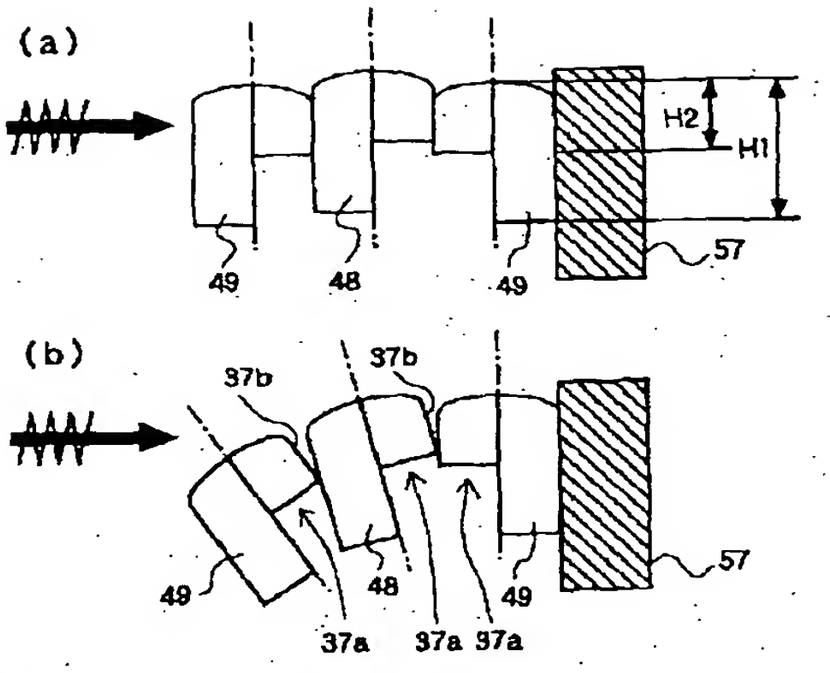
[Drawing 16]



[Drawing 17]



[Drawing 18]



[Translation done.]